Quantifying whitening using quantitative light-induced fluorescence in a product test model

The use of QLF to quantify in vitro whitening in a product testing model by I. A. Pretty, W. M. Edgar and S. M. Higham
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Background
Professional and consumer interest in whitening products continues to increase against a background of both increased oral health awareness and demand for cosmetic procedures. In the current legal climate, few dentists are providing 'in-office' whitening treatments, and thus many patients turn to home-use products. The most common of these are the whitening toothpastes. Researchers are keen to quantify the effectiveness of such products through clinically relevant trials.

Aim
Previous studies examining whitening products have employed a variety of stained substrates to monitor stain removal. This study aimed to quantify the removal of stain from human enamel using a new device, quantitative light-induced fluorescence (QLF). The experimental design follows that of a product-testing model.

Materials and method
A total of 11 previously extracted molar teeth were coated with transparent nail varnish leaving an exposed window of enamel. The sound, exposed enamel was subject to a staining regime of human saliva, chlorhexidine and tea. Each of the eleven teeth was subjected to serial exposures of a positive control (Bocasan), a negative control (water) and a test product (Yotuel toothpaste). Following each two-minute exposure QLF images of the teeth were taken (a total of 5 applications). Following completion of one test solution, the teeth were cleaned, re-stained and the procedure repeated with the next solution. QLF images were stored on a PC and analysed by a blinded single examiner. The ΔQ value at 5% threshold was reported. ANOVA and paired t-tests were used to analyse the data.

Results
The study confirmed the ability of QLF to longitudinally quantify stain reduction from human enamel. The reliability of the technique in relation to positive and negative test controls was proven. The positive control had a significantly (α=0.05) higher stain removal efficacy than water (p=0.023) and Yotuel (p=0.046). Yotuel was more effective than water (p=0.023).

Conclusion
The research community, the practicing clinician and the consumer all require sound product evaluation data. The use of human enamel specimens may offer more relevant clinical data. QLF has been designed as an *in vivo* device. Further development of the technique should permit *in vivo* clinical whitening trials.

In Brief
- Whitening products are of great interest to consumers who will frequently question their dentists about efficacy
- Previous *in vitro* techniques have employed non-enamel stained substrates
- QLF is an optical device which can monitor extrinsic stain reduction from human enamel *in vitro*
- The device may be employed to monitor *in vivo* whitening effects

Comment

The demand for tooth whitening has been steadily growing over recent years. Consequently, methods capable of examining the comparative efficacies of whitening toothpastes receive prominent attention. Although many studies have undertaken measurement of the whitening effects of toothpastes and bleaches, there is disagreement over the actual instrumental methods used for measurement. The authors of this paper have used a technique that has recently gained credibility in caries research.

Quantitative light induced fluorescence relies on the tooth tissue under scrutiny relaying an initially standardised fluorescent beam back to source with its own autofluorescent signature. This method has been used previously to differentiate between incipient caries and sound tooth tissue. From research generated by their own team, the authors have extrapolated this phenomenon to examine the differences between unstained and artificially stained enamel in the laboratory. Based upon a system in use for the last 20 years, staining was induced. However, modifications by the team allowed for use of tooth samples, so the method has clinical potential. Once performed, it is possible to examine stored images of samples and compare effects to the baseline.

After staining and treatment in succession, samples were then cleaned to baseline levels to be subjected to the other treatments. This way, a kind of crossover was achieved, allowing all samples to receive all treatments. Consequently, this study was able to not only compare treatment efficacies, but also to explore the validity of this equipment to measure stain.

Results indicated that the measurement technique was capable of discriminating between treatment groups, and statistics upheld this effect. It also could be seen that the successive treatments of the test toothpaste produced a progressively increasing stain removal effect, whereas the positive control, a peroxyborate mouthrinse, removed the majority of stain after a single application. Water was deservedly chosen as a negative control for its consistent inability to remove stain.

It remains to be seen whether the method bears up to reproducibility testing for inter and intra-examiner use. Also, it might have been useful to use other more widely accepted stain appraisal methods in parallel with this study for confirmation of the findings.

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